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April 16, 1997
(By Hand Delivery)

Mr. William F. Caton
Acting Secretary
Federal Communications Commission
1919 M Street, N.W.
Washington, DC 20554

Re: CC Docket No. 92-166

Dear Mr. Caton:

Enclosed, on behalf of TRW Inc., are the original and eleven copies each of TRW's Motion for Leave to Supplement its pending Petition for Further Reconsideration in the above-referenced proceeding, and the Supplement to that Petition for Further Reconsideration. The attached documents are revised versions of documents that were initially filed with the Commission on March 27, 1997 in the same proceeding. Until so apprised by the Commission, we were unaware that materials included with the earlier versions of these documents were considered inappropriate for such use.

TRW hereby requests that the March 27, 1997 versions of the pleadings be removed from the record of this proceeding, and that the attached pleadings be accepted in their stead. This result would have the additional effect of resolving the concern highlighted in the opposition Motorola Satellite Communications, Inc. filed with the Commission (but did not serve on TRW) last week.

Please do not hesitate to call if you have questions concerning the attached documents or the procedure requested in this letter.

Respectfully yours,

Stephen D. Baruch

SDB:kbs
Enclosures
cc: Service List

BEFORE THE

Federal Communications Commission

WASHINGTON, D.C. 20554

In the Matter of	)	
	)	
Amendment of the Commission's Rules to Establish Rules and Policies Pertaining to a Mobile-Satellite Service in the 1610-1626.5/ 2483.5-2500 MHz Frequency Bands	)	CC Docket No. 92-166

To: The Commission

MOTION FOR LEAVE TO SUPPLEMENT PETITION FOR FURTHER RECONSIDERATION

TRW Inc., by counsel, hereby requests leave to supplement its pending Petition for Further Reconsideration, filed April 11, 1996 in the above-referenced docket. TRW respectfully submits that accepting its supplement will serve the public interest by updating the record in this proceeding to include important recent developments that bear directly on the need for an interim band sharing plan for Mobile-Satellite Service ("MSS") systems operating in the 1610 - 1626.5 MHz frequency band.

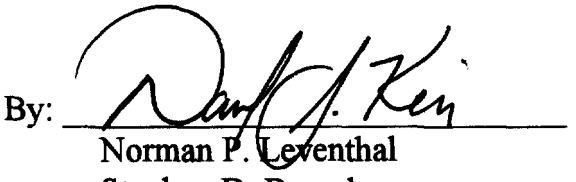
As explained fully in the attached Supplement, events that have taken place over the past year in various domestic and international fora, and particularly those that have occurred in recent weeks, demonstrate that the Commission was overly optimistic in concluding that the interim MSS band sharing plan for the 1610 - 1626.5 MHz band was unlikely to be necessary. In fact, present demands for near-term use of a significant

portion of this spectrum by the Russian Global Navigation Satellite System ("GLONASS") make it less likely than ever that the full 16.5 MHz of MSS spectrum in this band will be available for MSS use during the period when these systems are likely to commence operations.

Consideration of this additional information will update the record in this proceeding, informing the Commission with the most recent relevant information concerning the likely configuration of the GLONASS system during the period from the present until the year 2005, and will thus assist the Commission in deciding the important issues before it on reconsideration. Accordingly, TRW respectfully requests that the Commission accept and consider the attached supplement to its April 11, 1996 Petition for Further Reconsideration in the above-referenced docket.

Respectfully submitted,

TRW INC.

By: 

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April 16, 1997

Its Attorneys

91177/041697/03:13

CERTIFICATE OF SERVICE

I, Vera L. Pulley, hereby certify that a true and correct copy of the foregoing "Motion for Leave to Supplement Petition for Further Reconsideration" was mailed, first-class postage prepaid, this 16th day of April, 1997 to each of the following:

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Federal Communications Commission
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Washington, D.C. 20554

*Commissioner James H. Quello
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Federal Communications Commission
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91417/041697/03:17

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Vera L. Pulley

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BEFORE THE

Federal Communications Commission

WASHINGTON, D.C. 20554

In the Matter of	)	
	)	
Amendment of the Commission's Rules to Establish Rules and Policies Pertaining to a Mobile-Satellite Service in the 1610-1626.5/ 2483.5-2500 MHz Frequency Bands	)	CC Docket No. 92-166

To: The Commission

SUPPLEMENT TO PETITION FOR FURTHER RECONSIDERATION

TRW Inc. ("TRW"), by its attorneys, hereby supplements its Petition for Further Reconsideration, filed April 11, 1996 ("Petition"), and its Reply, filed May 30, 1996, in the above-captioned proceeding. This supplement provides critical information about events that have occurred in recent weeks that are directly relevant to the subject of TRW's Petition for Further Reconsideration, and brings the record of this proceeding up to date with respect to the current status of negotiations concerning the future operation of the Russian Global Navigation Satellite System ("GLONASS"). It is axiomatic that the extent to which the operations of GLONASS — both in the band 1610-1626.5 MHz in the near term, and in proximate bands upon reconfiguration and potential incorporation into the

Global Navigation Satellite System ("GNSS") — will have a direct impact on TRW's use of spectrum in the 1610 to 1626.5 MHz frequency bands to provide Mobile-Satellite Service ("MSS").

TRW's Petition urged the Commission to maintain the interim spectrum sharing plan for MSS systems operating in the frequency bands at 1610 to 1626.5 MHz ("MSS Above 1 GHz Service"), which the Commission had adopted in November 1994, until uncertainties over the potential near term impact of GLONASS operations on this MSS spectrum were resolved, and a definitive timetable was adopted to limit GLONASS to frequencies that would not impinge upon MSS operations in the band 1610-1626.5 MHz. TRW's Petition responded to the Commission's decision on reconsideration to remove the interim plan without pointing to any change in the circumstances that led to the initial imposition of the plan.

As demonstrated herein, the need for the interim band sharing plan has become even more acute in recent weeks. The plans for GLONASS currently being advanced by the Russian Federation contemplate more severe and longer lasting restrictions on MSS use of this spectrum than even those originally envisioned when the Commission adopted the interim plan. Resolution of this issue does not appear imminent, and it is likely that any negotiated accommodation will require restrictions on MSS use of the 1610-1626.5 MHz spectrum during the period prior to the year 2005. For these reasons, the Commission should reinstate the interim band sharing plan for the MSS Above 1 GHz Service.

BACKGROUND

In its initial Report & Order in CC Docket 92-166, the Commission concluded that it was necessary to adopt an interim spectrum sharing plan for MSS in the 1610-1626.5 MHz band because of uncertainties concerning spectrum use by the GLONASS system and its impact upon the MSS Above 1 GHz Service. The Commission recognized that use of GLONASS in conjunction with the U.S. Global Positioning System ("GPS") to provide aircraft precision approach and terminal communications could preclude co-frequency operation of non-geostationary MSS transmitters due to the strong potential for interference with GLONASS mobile receivers.[1/] The Commission further concluded that, although the exact spectrum requirements for GLONASS were undetermined, in the event that GLONASS did not move to bands below 1606 MHz before the first MSS satellites were launched, there would be a clear need for a transitional spectrum use plan for MSS until there was no further possibility of conflict with GLONASS.[2/]

In an effort to prevent the burden of GLONASS constraints on this spectrum from falling more heavily upon the MSS systems operating in the lower portion of the 1610-1626.5 MHz band, the Commission adopted its interim band sharing plan as a means of

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1/ See Amendment of the Commission's Rules to Establish Rules and Policies Pertaining to a Mobile Satellite Service in the 1610-1626.5/2483.5-2500 MHz Frequency Bands, 9 FCC Rcd 5936, 5956 (¶ 49) (1994) ("Big LEO R&O").

2/ See Big LEO R&O, 9 FCC Rcd at 5957 (¶ 49).

equitably apportioning the short-term encumbrance on the spectrum among the system operators.[3/] Despite the uncertainties relating to the need for this plan, the Commission expressed optimism "that these measures will not be necessary or, if they are, that the effect on the MSS industry will not be significant given their short term nature and the anticipated incremental implementation of the Big LEO service."[4/]

In its Memorandum Opinion & Order on reconsideration, the Commission diametrically changed its course. Although there had been no change in the underlying circumstances relating to GLONASS that initially prompted it to adopt the interim plan, the Commission decided to abandon its original approach "given the substantial uncertainty as to whether protection of GLONASS will ever be necessary in any configuration other than its final configuration at frequencies below 1606 MHz . . ."[5/] This determination was based, in significant part, upon contentions by LQL and Motorola that an interim plan should only be adopted after protection criteria are developed for GLONASS receivers by the responsible advisory committee to the Federal Aviation Administration ("FAA").[6/] The Commission reasoned that the interim sharing plan was not then necessary to protect

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3/ See id. at 5959 (¶ 53).

4/ Id.

5/ See Amendment of the Commission's Rules to Establish Rules and Policies Pertaining to a Mobile Satellite Service in the 1610-1626.5/2483.5-2500 MHz Frequency Band, 11 FCC Rcd 12861, 12865 (¶ 14) (1996) ("Big LEO Recon. Order").

6/ See Big LEO Recon. Order, 11 FCC Rcd at 12865 (¶ 13).

GLONASS operations in the United States because GLONASS had not been incorporated into or accepted as part of the overall Global Navigation Satellite System ("GNSS"), either domestically or by the International Civil Aviation Organization ("ICAO").

TRW sought reconsideration of this decision because the Commission offered no justification for its policy reversal — absolutely nothing had changed to indicate a more promising outlook for resolution of the GLONASS sharing issues that initially prompted the Commission to adopt is interim sharing plan in November 1994. As TRW then noted, "[a]ll of the uncertainties noted by the Commission in the Big LEO R&O as to when, if ever, the transition in GLONASS operations would occur remain, and the out-of-band emission restrictions to be imposed are no closer to being resolved than they were 18 months ago."[7/]

In the intervening year since TRW sought reconsideration, and especially in the last few weeks, the uncertainties cited by TRW have deepened. It has become increasingly clear that the Commission's desire for a resolution of these issues without the need for a provisional spectrum sharing plan has been thwarted. As detailed further below, the asserted operational limitations necessary to protect GLONASS have actually become more onerous than those initially assumed by the Commission; and there now appears to be little likelihood that MSS systems can meaningfully begin operation without the implementation of the Commission's interim band plan.

7/ Petition of TRW Inc. for Further Reconsideration, CC Docket No. 92-166, at 5-6 (filed April 11, 1996).

RECENT DEVELOPMENTS

Since the Commission's implicit conclusion that the GLONASS system was likely to be reconfigured for use of frequencies exclusively below 1606 MHz before MSS mobile earth stations ("MESs") begin operating in the 1610-1626.5 MHz frequency band, discussions have continued within various bodies looking toward an agreement on the MES operating characteristics sufficient to protect GLONASS operations, as well as the timetable for the movement of GLONASS below the 1610-1626.5 MHz band. Separate groups within both the U.S. and ICAO are also considering the appropriate standard for out-of-band emissions limitations on MSS MES terminals.

In a very recent submission to the ITU, the Russian administration has insisted that GLONASS spectrum usage be protected in a way that would preclude co-frequency MSS operations in portions of the 1610-1626.5 MHz band in the following manner and for the following periods:

1610-1620.61 MHz	Until 1999
1610-1613.86 MHz	From 1999-2008
Up to 1609.36	After 2008

See Attachment hereto, Document SG8D/SRG/5 (and Corr. 1), "Protection of Receivers in the Radionavigation-Satellite Service Systems From Interference Produced By Earth Stations In Mobile-Satellite Service Systems," at 7, dated March 4-6, 1997. Moreover,

regardless of the appropriate transition periods to lower frequencies, the Russians have suggested that it is necessary during each of these periods (and beyond) to limit out-of-band emissions from MSS mobile earth stations to -70 dBW/1 MHz in the bands where GLONASS continues to operate. This emissions parameter is substantially more restrictive than the level believed sufficient by U.S. MSS systems, and could significantly impede the development of MSS, if adopted.

At the same time that coordination discussions have been taking place through the ITU, U.S. and international aviation bodies have been engaged in evaluation of the GLONASS system for inclusion in the overall GNSS system. In these proceedings, the U.S. aviation community has strongly supported protections that, while less audacious than the Russian proposals, would nonetheless limit MSS band use for an extended transition period. For example, a recent draft paper circulated by these interests within ICAO suggests that GLONASS should operate up to approximately 1609 MHz through the year 2005 with an additional guardband above the 1610 band edge.[8/]

TRW believes that a tolerable compromise between the views of the aviation community and the licensed MSS systems can ultimately be reached. In view of the

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8/ Recently, the circumstances regarding interservice sharing in this portion of the L-Band have been further complicated by Motorola's decision to seek FCC approval to provide aeronautical mobile-satellite (route) service ("AMS(R)S") using its Iridium MSS system. See Application of Motorola Satellite Communications, Inc., File No. 18-SAT-ML-87 (filed December 4, 1996). This proposal raises additional interference and spectrum issues that must be considered along with the GLONASS/MSS sharing situation.

expansive GLONASS requirements being asserted by the Russians, however, the view advanced in the ICAO documents may be the most likely scenario for near-term implementation of MSS. Yet even under this plan, there is no question that a transitional spectrum sharing approach along the lines of the original interim band plan will be necessary.

The Commission's decision to rescind its initial adoption of the interim plan was premised on the belief that GLONASS was quite likely to move entirely to frequencies below 1606 MHz prior to MSS implementation. Because recent events have made prospects for realizing this hopeful scenario slimmer than ever before, the interim plan is more necessary now than when it was initially conceived and approved by the Commission. Accordingly, the Commission should reinstitute its interim band sharing plan for the 1610 to 1626.5 MHz band at this time.

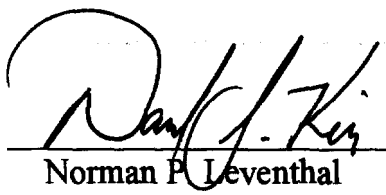
CONCLUSION

Based on the foregoing facts, as well as the arguments made previously in TRW's Petition for Further Reconsideration, there is no doubt that the original interim band plan remains a necessary aspect of the Commission's plan for implementation of MSS

Above 1 GHz Service, and should therefore be reinstated expeditiously to ensure that this new service can be initiated in an orderly and equitable manner.

Respectfully submitted,

TRW Inc.

By: 

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April 16, 1997

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ATTACHMENT

INTERNATIONAL TELECOMMUNICATION UNION
RADIOCOMMUNICATION
STUDY GROUPS

Corr. 1 to
Document SG8D/SRG/5
4-6 March 1997
Original: Russian\English

Source: Circular Letter 8/LCCE/40
Subject: Question ITU-R 210/8

Russian Federation

PROTECTION OF RECEIVERS IN THE RADIONAVIGATION-SATELLITE SERVICE SYSTEMS FROM INTERFERENCE PRODUCED BY EARTH STATIONS IN MOBILE-SATELLITE SERVICE SYSTEMS

Introduction

Working Party 8D's Sixth Meeting (Geneva, 29 October - 8 November 1996) set up a Special Rapporteurs Group to assist in the preparation of a draft new Recommendation "Essential Technical Requirements of Mobile Earth Stations for Non-Geostationary Mobile-Satellite Service in the Bands 1 - 3 GHz". The Draft proposes requirements for Mobile Earth Stations (MES) that affect interests of users in the Radionavigation-Satellite Service (RNSS) systems.

The Sixth Meeting also adopted Draft New Question "Spurious Emission Limits" (Doc.8D/TEMP/100(Rev.1)) that includes, in particular, determination of practical spurious emission levels that can be achieved by the Mobile-Satellite Service in its various bands. The studies of this Question should be conducted with appropriate regards of requirements for MES unwanted emissions defined in the discussed preliminary draft new Recommendation.

The document presented by the Russian Federation deals with justification of limitations required for MES operation and includes proposals for modification of the preliminary draft new Recommendation.

1. Regulatory Provisions Related to Protection of the RNSS Systems

Systems in the Radionavigation Service including Radionavigation-Satellite Service (RNSS) provide navigation support for aeronautical, maritime and land users and the systems constitute one of the essential elements for ensuring safety of their traffic. The ITU's Radio Regulations (RR) provisions grant them specific protection from interference emissions from stations of other services.

S4.10 (RR 953) states that:

> " Members recognize that the safety aspects of radionavigation and other safety services require special measures to ensure their freedom from harmful interference; it is necessary therefore to take this factor into account in the assignment and use of frequencies"

Since unwanted emissions produced by newly notified in the ITU stations of other radioservices (MSS including) to which adjacent bands are allocated could have potential of harmful interference to the RNSS systems which are already operate and were previously notified at the ITU then it should be taken into consideration that subject to S4.5 (RR 343) :

> "The frequency assigned to a station of a given service shall be separated from the limits of the band allocated to this service in such a way that, taking account of the frequency band assigned to a station, no harmful interference is caused to

2. The Problems of Sharing between RNSS and MSS

WARC-92 allocated additional bands for MSS in certain frequency ranges. Specifically, such allocations were made on a primary basis in the frequency band 1610 - 1626.5 MHz (Earth-to-space) in all the three Regions. At the time of those allocations in the 1.6 GHz band two global satellite systems (GPS and GLONASS) were notified at the ITU and operated within the framework of the RNSS. When the frequency bands were allocated for the MSS the conditions for sharing between MESs and the RNSS receivers had not been specified ultimately.

Due to a global nature of the RNSS and MSS systems as well as availability of mobile users it is not practical to maintain coordination distances between them. Employment of omnidirectional antennas in the systems of those services excludes interference spatial discrimination. Such a position resulted in requirement for working out limitations and specifications on the MES operation in the frequency bands used by the RNSS systems.

GPS and GLONASS systems now operating in the RNSS need protection from the MESs emissions. It should be mentioned that GPS system receivers could be affected only by MES unwanted emissions. In contrast, interference to the GLONASS receivers could be produced both by basic (during co-frequency operation) and by unwanted (during operation in unoverlapping frequency bands) MES emissions. Thus the problem of sharing between the GLONASS system and the MSS systems is more pressing and only this system will be discussed hereafter .

3. Primary Directions of the GLONASS System Development

The GLONASS system was registered at the ITU in 1988 and formally brought into regular operation in 1993.

In 1988 the Soviet Union made a proposal to the International Civil Aviation Organization (ICAO) offering an international applications of the GLONASS system navigation sphere.

In March 1996 the 147-th Session of the ICAO Council decided to incorporate the GLONASS system as part of the advanced international Global Navigation Satellite System (GNSS).

Estimations undertaken by the ICAO experts (GNSS Panel) showed that only joint operation of GLONASS and GPS systems within the GNSS could ensure high-precision position-fixing with concurrent required integrity of the GNSS as essential provision for flight safety.

In addition to application of the GLONASS system for aeronautical navigation it is also planned for operation to ensure navigation of maritime and land mobile users. Now Russian Federation undertakes harmonization of standards being developed by the International Maritime Radiotechnical Commission (RTCM) at the International Maritime Organization (IMO) to operate differential GLONASS and GPS systems for maritime navigation.

To provide electromagnetic compatibility of the GLONASS system in the 1.6 GHz band with the Radioastronomy and Mobile-Satellite Services the GLONASS System Frequency Plan is now under modification. The modification is to be undertaken in three stages [1].

Up to 1999 the GLONASS system will use operational channels labeled 0...12 and 22...24. Channels labeled 13, 14 and 21 (carrier frequencies 1609.3125 MHz, 1609.875 MHz and 1613.8125 MHz) will be used only on an exceptional basis. Besides, replacement satellites will operate channels labeled (-7) ... (-1) (carrier frequencies from 1598.0625 MHz to 1601.4375 MHz). The total band of operational frequencies used by the GLONASS system at the stage will be 1597.5115 - 1616.011 MHz for Standard Accuracy Signal (SAS) and 1592.9525 - 1620.61 MHz for Precision Accuracy Signal (PAS).

At the second stage (1999 - 2005) channels labeled 0...12 will be used in the GLONASS system. Channel labeled 13 (carrier frequency 1609.3125 MHz) will be used only on exceptional basis. Replacement satellite would also operate in channels labeled (-7) ...(-1). The total band of operational frequencies used by the GLONASS system at the stage will be 1597.5115 - 1609.261 MHz for SAS-signal and 1592.9525 - 1613.86 MHz for PAS-signal.

After 2005 the GLONASS system will use channels labeled (-7)...4. Channels labeled 5 and 6 (carrier frequencies 1604.8125 MHz and 1605.3750 MHz) would be used as technical channels (for launch and tests) when satellites are over the Russian territory. The total band of operational frequencies used by the GLONASS system at the stage will be 1597.5115 - 1604.761 MHz for SAS-signal and 1592.9525 - 1609.36 MHz for PAS-signal.

Up to 2005 existed would be the overlapping of the frequency bands allocated to the MSS systems and used by the GLONASS system (1610-1620.61 MHz up to 1999 and 1610-1613.86 MHz up to 2005) with probability of causing interference to GLONASS receivers from primary MES emissions. After 2005 GLONASS receivers would be affected by interference originated from unwanted MSS earth stations emissions in the course of operation in unintersecting frequency bands. Thus requirements emerge to limit primary and unwanted MES emissions for protecting GLONASS receivers.

4. Justification of Required limitations for MES emissions

4.1. Probable Scenarios of Interference

To estimate probable interference from MSS earth stations the following scenarios of GLONASS receivers operation by aeronautical, maritime and land users were considered.

For Aeronautical Users

Based on the GNSS concept the navigation support tasks would be solved at [2]:

- en-route and pre-approach area flight;
- non-precision and categorized approach.

Table 1

Specifications for Navigation Aids application

Flight stages to be supported by the GNSS	Minimal altitude, m	References
En-route flight	150	[3]
Pre-approach zone flight	150	[3]
Approach and landing		
• non-precision	76.0	[4]
• categorized (Category I)	61.0	[4]

Analysis of data shown in Table 1 results in identifying probable interference scenarios emerging in the course of GNSS and MSS systems operation.

Scenario 1

During an aircraft en-route flight at the minimal altitude MSS single users may stay at a distance of up to 150 m from the aircraft (e.g., when roads or small inhabited areas are located directly under the aircraft path). In such a case the GLONASS receiver antenna gain would be (-6) dB in the direction of the interference signal

Scenario 2

When flying in an approach zone at the minimal altitude an aircraft may maneuver (roll angle would be ± 25° and pitch angle would be -1°...+5°). In such a case MSS single users may stay at a distance of up to 150 m from the aircraft, The GLONASS user terminal antenna gain in the direction to an interference signal is 0 dB.

Scenario 3

When an aircraft performs a non-precision approach MSS single users may stay at a distance of up to 75 m from the aircraft (e.g., when roads are directly below the approaching aircraft path). The GLONASS user terminal antenna gain in the direction to an interference signal is minus 6 dB.

Scenario 4

When an aircraft performs a categorized approach (Category I) MSS single users may stay at a distance of up to 60 m from the aircraft (e.g., when roads are directly below the approaching aircraft path). The GLONASS user terminal antenna gain in the direction to an interference signal is minus 6 dB.

A probable scenario could feature a MES operating aboard an aircraft navigating by means of a GLONASS receiver. In such cases electromagnetic compatibility between those devices should be related to intraobject compatibility of on-board avionics equipment and the present contribution does not consider such an interference scenario.

For Maritime Users

Estimation of probable interference from MESs to GLONASS receivers located in maritime ships features a scenario when a MSS earth station operates aboard a ship navigating with a GLONASS receiver. It was assumed that distance between the GLONASS receiver antenna installed at a mast and the MSS user on the ship deck was 50 meters. The GLONASS user terminal antenna gain in the direction to an interference signal is minus 6 dB.

For Land Users

For GLONASS land users an interference scenario assumed a car-based GLONASS receiver affected by a MES transmitting from another car moving in parallel. The assumed distance between the GLONASS receiver antenna and the MES was 100 meters. The GLONASS user terminal antenna gain in the direction to an interference signal is 0 dB.

4.2. Justification of Limitations on MES Primary Emissions in the GLONASS band

The frequency bands 1610 - 1620.61 MHz (up to 1999) and 1610 - 1613.86 MHz (up to 2005) will be used by the GLONASS system on the primary basis to support aeronautical users subject to S5.366 (RR № 732). Therefore justification of limitations on the MES primary emissions in the frequency band 1610 - 1626.5 MHz was conducted in relation to interference scenarios for aeronautical users.

When estimating C/I protection ratio deficit for the GLONASS receivers the Globalstar (CDMA) and Iridium (TDMA) terminals were used as typical MESs. Table 2 shows assumptions for the above scenarios of interference produced by MESs into GLONASS aeronautical receivers.

The protection ratio deficit $Def_{(C/I)}$ estimation for GLONASS receivers was as follows :

1. C/I ratio at the input (front end) of the GLONASS navigation receiver was calculated as:

$$C/I = P_{min} - G(\theta) - P_i - G_i + L - N - K,$$

where

K - a factor of relation between signal and interference frequency bands:

$$K = 10 * lg(B_w/B_i), \quad \text{for } B_i > B_w,$$

$$K = 0 \quad \text{for } B_i \le B_w.$$

2. The deficit of protection ratio for the GLONASS receiver was calculated as :

$$Def_{(C/I)} = (C/I)_{per} - C/I.$$

The results are shown in Table 3.

Table 2

Assumptions used for estimating the interference levels to navigation receivers of the GLONASS aeronautical users

Parameter	Parameter symbol	Scenarios of interference to aeronautical users			
		1	2	3	4
Minimum level of the GLONASS satellite signal at the navigation receiver input, dBW	P_{min}	-161			
Permitted C/I level at the navigation receiver input for SAS (PAS), dB	$(C/I)_{per}$	-15 (-25)			
Antenna gain for the GLONASS navigation receiver in the direction of interference source, dB	$G(\theta)$	-6	0	-6	-6
Average path losses between the GLONASS receiver antenna and interference sources, dB	L	80	80	74	72
Factor of multiple interference sources, dB	N	0			
Globalstar/Iridium transmitting earth station power, dBW	Pi	-2.0 / 5.0			
Globalstar/Iridium MES antenna gain, dB	Gi	-1.0 / 1.0			
GLONASS signal bandwidth for SAS(PAS), kHz	Bw	1022 (10220)			
Globalstar/Iridium interference signal bandwidth, kHz	Bi	1230/31.5			

Table 3

Calculations results of $(Def_{(C/I)})$ at the input of GLONASS aeronautical user receiver for SAS (PAS), dB

Interfering system	Interference scenarios for aeronautical users			
	1	2	3	4
Iridium	66 (56)	72 (62)	72 (62)	74 (64)
Globalstar	56.2	62.2	62.2	64.2

Analysis of results presented in Table 3 shows that in case of co-frequency operation the level of interference produced by MSS earth stations at the receiver input would significantly exceed the permitted level.

Due to that it would be appropriate to put MSS systems into operation in the frequency band 1610-1626.5 MHz with relevant regards to the modifications of the GLONASS System Frequency Plan and operational lifetime of the developed navigation receivers (10 years).

Based on actual amplitude-frequency characteristics of the GLONASS receivers (orthogonality coefficient = 1.3 for -40 dB level) the additional protection band is required between the frequency bands used by GLONASS receivers and MSS transmitters.

Based on the above the MES should not operate in the following frequency bands :

- 1610.0 - 1623.0 МГц - up to 1999;
- 1610.0 - 1615.0 МГц - from 1999 to 2008.

The above limitations should be observed in-line with shown below values for unwanted emissions of the MSS earth stations out of operational frequency band.

4.3. Justification of Limitations on MES Unwanted Emissions in the GLONASS band

Justification of limitations on the MES unwanted emissions in the GLONASS frequency band the above interference scenarios for all user types were used. Permitted value of e.i.r.p. for MES unwanted emissions was estimated using the following formula :

$$W = P_{min} - (C / I)_{per} - G(\theta) + L - N.$$

Assumptions and calculation results are presented in Table 4.

Table 4

Calculation of permitted levels for unwanted emissions produced by the MSS transmitting earth stations

Parameter	Parameter symbol	Scenarios of interference to various users					
		For aeronautical				For maritime	For land
		1	2	3	4		
Minimum level of the GLONASS satellite signal at the navigation receiver input, dBW	P_{min}	- 161					
Permitted C/I ratio specified for the receiver in 1 MHz bandwidth, dBW/MHz	$(C/I)_{per}$	-15					
Antenna gain for the GLONASS navigation receiver in the direction of interference source, dB	$G(\theta)$	-6	0	-6	-6	-6	0
Average path losses between the GLONASS receiver antenna and interference sources, dB	L	80	80	74	72	70.5	76.5
Factor of multiple interference sources, dB	N	0					
Permitted value for e.i.r.p. of the MSS transmitters unwanted emissions in 1 MHz bandwidth, dBW/MHz	W	-60	-69	-66	-68	-69	-69.5

Thus taking into account a staged modification of the GLONASS Frequency Plan and GLONASS receiver operational lifetime the maximum possible level of MES unwanted emissions in the GLONASS band should not exceed :

minus 70 dBW in 1 MHz in the band 1592.9525 - 1620.61 MHz up to 1999;
in the band 1592.9525 - 1613.86 MHz from 1999 to 2008;
in the band 1592.9525 - 1609.36 MHz after 2008.

Conclusions

1. The GLONASS system usage in the Radionavigation-Satellite Service and specifically in the advanced international Global Navigation Satellite System (GNSS) for navigation support of aircraft and maritime ships as well as for land vehicle position-fixing stipulates the requirements for comprehensive search and universal implementation of arrangements for protecting the GLONASS users from interference produced by other radioservices.

2. Use of the frequency band 1610-1626.5 MGz by terminals MES should be carried out in view of protection GLONASS receivers. Therefore the MES should not operate in the following frequency bands:

- 1610.0 - 1623.0 MHz - up to 1999;
- 1610.0 - 1615.0 MHz - from 1999 to 2008.

3. The maximum possible level of MES unwanted emissions in the GLONASS band should not exceed :

minus 70 dBW in 1 MHz in the band 1592.9525 - 1620.61 MHz up to 1999;
in the band 1592.9525 - 1613.86 MHz from 1999 to 2008;
in the band 1592.9525 - 1609.36 MHz after 2008.

It is worth mentioning that the interference scenarios discussed in the contribution deal with probability of interference to GLONASS receivers from single sources. It is obvious that real situations would feature the factor for interference sources (N) that would differ from 0.

4. Based on the above it is proposed to modify Annexes 1, 2a and 2 b of the PDNR "Essential Technical Requirements of Mobile Earth Stations for Non-Geostationary Mobile-Satellite Service in the Bands 1 - 3 GHz ". The proposed wording is presented in the Supplement to the present contribution.

References

1. Doc.8D/TEMP/136 of November 06, 1996. Draft New Recommendation ITU-R M.[XXX] "Consideration for Sharing between Systems of Other Services Operating in the Bands Allocated to the Radionavigation-Satellite and Aeronautical Radionavigation Services and the Global Navigation Satellite System (GLONASS-M)".
2. Doc. COM/OPS/95 (ICAO)
3. Doc. 8168-OPS/611 (vol. I) (ICAO)
4 Doc. 9365-AN/910 (ICAO)

SUPPLEMENT

Proposals for modifications to the Preliminary Draft New Recommendation "Essential Technical Requirements of Mobile Earth Stations for Global Non-Geostationary Mobile-Satellite Service in the Bands 1 - 3 GHz"

(Doc.8D/TEMP/144-E)

Modifications to Annex 1

ANNEX 1
Essential Technical Requirements of MES for Global NGSO MSS Systems in the bands 1 - 3 GHz

This Annex contains essential technical requirements for MES terminals of global NGSO MSS systems operating in the bands 1 - 3 GHz. ~~The tables on the following pages of this Annex summarize the maximum unwanted emission requirements for such terminals. In addition to these unwanted emission requirements there is an additional requirement for automatic shut-off features of MES terminals which is:~~

These requirements are:

a) restrictions on operation in the frequency band 1610 - 1626.5 MHz up to 2008;

b) requirements for the MSS terminals unwanted emissions specified in the below tables;

c) requirements for automatic shut-off features of MSS terminals.

Restrictions on operation in the frequency band 1610 - 1626.5 MHz:

The frequency band 1610-1626.5 MHz should be used by MES terminals ensuring required protection of GLONASS receivers. Therefore the MES should not operate in the following frequency bands :

- 1610.0 - 1623.0 MHz - up to 1999;
- 1610.0 - 1615.0 MHz - from 1999 to 2008.

Automatic Shut-off Features: The MES shall include a means of identifying whether there is a malfunctioning processor or other fault in its operation and be capable of automatically shutting down transmissions in the case of an identified malfunction no later than one second after a malfunction has been identified.

Throughout this Recommendation, various terms, which are defined in the Radio regulations are used. In addition to these terms there is an additional essential term which must be defined as follows:

Nominated bandwidth (B_n): The B_n of the Mobile earth station (MES) radio frequency transmission is wide enough to encompass all spectral elements of the transmission which have a level greater than the specified levels of unwanted emissions. The B_n is defined relative to the MES actual carrier frequency f_c.

B_n is the width of the frequency interval (f_c -a, f_c +b), where a and b, which shall be specified by the terminal manufacturer, may vary with f_c.

The frequency interval (f_c -a, f_c +b) shall not encompass more than either:

i) when a = b, 4 nominal carrier frequencies for narrow-band systems;

ii) when a ≠ b, 1 nominal carrier frequency for narrow-band systems; or

iii) 1 nominal carrier frequency for wide-band systems.

The frequency interval (f_c -a, f_c +b) shall be within the assigned band of the MES.